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Chemical Injection in Irrigation Systems

The idea of applying agricultural chemicals to a crop by mixing the chemicals with the irrigation water and applying the water in the normal fashion is not new. This idea has increased in popularity in recent years, as farmers continue to strive for greater production and further savings of labor and capital. This concept has been called fertigation when fertilizer is applied and herbigation when herbicides are used. Insecticides and fungicides have also been applied in this manner. In this publication, the term **chemical injection** will be used to cover all of the above situations. Dependable, accurate and more economical equipment and chemicals have become available which have added to the interest in chemical injection. Although chemicals can be applied with any method of irrigation, accurate application is easier with sprinkler and gated pipe systems. The farmer contemplating chemical injection should consider the following points.

Advantages

Many advantages of chemical injection have been cited. Some of the more important include:

- savings of the farmer's time during the irrigation season
- savings in equipment compared to applying chemicals by other methods
- better penetration of the crop canopy
- less drift than from aerial application
- less soil compaction
- crop is relatively undisturbed, no root pruning
- some specialized chemicals can be applied only by mixing with large quantities of water
- if soil texture is suitable, a certain amount of incorporation can be obtained; especially useful in placement of nitrogen fertilizers
- nitrogen can be applied as required during the growing season

Disadvantages

- capital cost may not be justifiable on smaller operations
- wind can cause uneven sprinkler coverage resulting in poor chemical distribution
- not suitable for applying all chemicals
- soil and tissue testing is required to make most efficient use of chemical injection of fertilizer
- few herbicides are licensed for sprinkler application in Canada

Before you invest in chemical injection equipment, many factors peculiar to your situation must be carefully considered. The first factor to consider is your crop. Chemical injection is not effective or economical on all crops. In times of rapidly changing prices of both farm inputs and farm products, it is difficult to give a definite list of crops that are suited to chemical injection. Generally speaking, any crop which uses a large amount of nutrients or is susceptible to weed infestation problems is a likely candidate for chemical injection. Sandy soils, prone to nitrogen leaching, are prime candidates for fertigation. This is why it is quite popular in some areas of the United States.

If you have any questions about the quality of your irrigation water, it is advisable to have it checked to make sure it will be compatible with the chemicals you intend to use. A sprinker system has the potential of applying chemicals at least as uniformly as a normal field sprayer. The uniformity of application of chemicals will only be as good as the uniformity of water application of your system. If you have an older system with worn sprinkers and gaskets, the chemical application is likely to be very spotty and, in turn, the crop response will be spotty.

Other considerations are field size, economics, manpower availability and power source. Because soil and tissue testing are required for best results from chemical injection, the farmer should make sure that these services will be readily available during the irrigation season.

What and How Much to Apply

A very limited number of chemicals are registered for application through irrigation systems in Canada. Consult the chemical label before applying any chemical through an irrigation system. Some chemicals used today (2,4-D for example) become too diluted to be effective, others will not mix well with the irrigation water. Both liquid and soluble fertilizers can be used providing the soluble fertilizers are properly mixed beforehand.

There are three types of fertilizers that can be used in irrigation systems.

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Clear liquids are the easiest to use because they do not settle out over a short period of time. Clear liquids are the most commonly used type in Alberta. Formulations presently available include 28-0-0, 20-0-5 and 10-34-0. These may be mixed before injection to produce the desired formulation for special circumstances. Micronutrients may also be added.

Suspension liquids contain more nutrients per unit measure, thereby supplying the required amounts of fertilizer with less weight or volume. Because of this high nutrient content, manufacturing, handling and application costs are lower than for clear liquids. The micronutrient content held in suspension is relatively larger. To assure proper distribution and uniform application, the volume and velocity of the irrigation water must be sufficient to maintain the fertilizer in suspension. This type of fertilizer requires in-tank agitation to maintain the suspension.

Dry fertilizer can be dissolved in a tank and then pumped into the irrigation system or it can be placed in a pressurized tank through which a portion of the irrigation stream passes. This type has the advantage of being easy to obtain and the disadvantage of requiring dissolving and subsequent agitation.

Some fertilizer solutions will damage crops if they are left on the leaf surface. For this reason, the crop should always be rinsed with clean water after the fertilizer application. This rinse also serves to clean the system of chemicals which may cause corrosion and clogging. Running the system for 20 to 30 minutes with clean water is recommended for "set type" systems. Center pivots can be set at maximum speed for a quick rotation after chemical injection. Fertilizer solutions can be very hard on pump parts and related equipment, these should also be rinsed after the application.

The amount of fertilizer required to meet crop requirements can be determined by soil and tissue testing as well as relying on past experience and technical advice. When to apply the nutrients can be as important as how much to apply. Certain crops will respond very favorably to chemical applications at certain stages of growth. One of the major advantages of chemical injection is the ability to tailor chemical applications to crop growth characteristics during the growing season.

Equipment

There are several methods of introducing chemicals into an irrigation system. The four most commonly used methods are outlined below:

Pitot Tube Injection — An open ended pipe is placed in the irrigation stream facing the flow of water and another is placed facing away from the flow. Both pipes are connected to a supply tank in which the chemical is placed. The tank must be constructed to withstand the maximum operating pressure of the system. A flow of water will be established through the tank, carrying the fertilizer into the irrigation stream. The rate of chemical application will vary as the chemical in the tank gradually becomes diluted and as a result is not applicable to continuous moving systems. This method is suitable for the use of dry chemicals because they do not have to be previously dissolved.

Venturi Principle of Injection — The theory on which this system operates is that a pressure drop accompanies the change in velocity of the water as it passes through the constriction. The pressure difference between a connection above the constriction and one in the constriction is sufficient to cause water to flow through the supply tank. This tank is the same as the one used for the pitot tube method, and again, the concentration of chemicals varies with time. This method is also useful when using dry chemicals.

Injection Pump Method — In this case a pump is used to force a solution from the supply tank into the irrigation stream. The pump must be operated at a higher pressure than the pump used to pressurize the irrigation water. The most common injection pumps are positive displacement piston pumps. The size of the piston, length of the stroke and speed of the piston determine the rate the chemical is applied. They are available in single and double piston models. The double piston units are useful where large quantities of chemical are to be applied or when you wish to apply both fertilizers and herbicides at the same time. All parts of the pump and all fittings which come in contact with the chemical should be made of a non-corrosive material. The injection pump can either be belt driven directly from the irrigation pumping plant or powered by a small gasoline or electric motor. Electric motors are available in various voltages to match most situations. The rate of chemical injection is constant with this method and is therefore suitable for center pivots and other continuous move systems. This injection pump method is popular in Alberta.

Pump Suction Method — This is rapidly becoming the most common method used to inject liquid fertilizer into sprinker systems. The only equipment required is a fertilizer supply tank, hoses, fittings and a specialized control valve. The suction created by the irrigation pump is used to draw liquid fertilizer into the sprinkler system. The control valve meters and regulates the fertilizer flow. The primary advantage of this system is the low equipment cost. The equipment must be set up properly to prevent fertilizer from entering the water source when the irrigation pump stops.

The chemical should be placed in the center of the irrigation stream to facilitate proper mixing. With any of the four methods mentioned, precautions must be taken to ensure that when the system shuts down, chemicals

cannot enter the suction line and the water supply causing pollution. In the first two methods, the chemical flow will stop when the system shuts off providing proper antisiphoning devices are used. Check valves should be used in both the irrigation line and the chemical line along with a vacuum release valve in the irrigation line. When using injection pumps, the irrigation pumping unit and the injection pump should be interlocked so that if the irrigation pump fails, the injection pump will shut down immediately.

Calibration of Equipment

The equipment must be calibrated to apply the proper amount of chemical, particularly with injection pumps. In systems which use a pressurized tank, chemical is added at the start of each set and it must be all gone at the end of it. The only calibration needed here is the calculation of the proper amount of chemical to use and setting the rate so that the chemical is all gone before the set is completed. Because the solution becomes gradually weaker as it mixes with the water it is only possible to use this system in set type systems where we know exactly how much area is covered per set.

When using an injection pump, or the pump suction method, the area covered over a period of time must be calculated as well as the amount of chemical applied in this period of time. The amount of chemical is then adjusted to provide the desired application rate. The importance of proper calibration cannot be overemphasized. Consult the equipment dealer and manufacturer's literature for more specific information on calibration of your particular pump.

Economic Considerations

Some of the points to consider when determining the economics of chemical injection include field size, predicted crop response, crop value, investment required for alternative chemical application equipment, operating costs for the injection equipment, relative chemical costs and investment cost. Approximate costs for the pressurized tank methods are not available because this equipment is not common in Alberta and is often homemade. Approximate equipment costs for the injection pump method and pump suction method (as of October, 1986) are as follows:

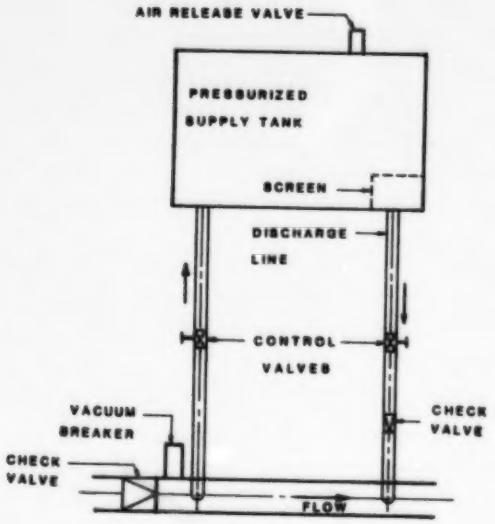
Injection pump and motor	$2,000 - $2,500 (depending on make, size and whether single or double piston)
Valve and hose kit for hookup	$100 - $200
Plastic tanks available in various sizes	$1,100 (1500 U.S. gallon - most common)
Labor for custom installation	$150 - $200
Control device for pump suction method	$200 - $300

Other options include timers, automatic shutoff, kill switches, etc.

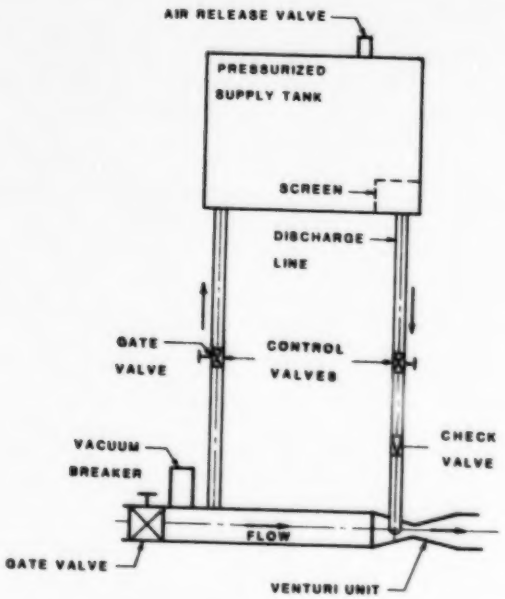
Conclusion

Each farmer should evaluate his own situation and decide if chemical injection would be profitable for his particular operation. In many cases, it is advisable to consider leasing or renting the equipment for the first year before deciding to purchase it.

If further information is required, contact the Irrigation Branch office in your area. Alberta Agriculture has irrigation staff in Bow Island, Brooks, Lethbridge, Medicine Hat, Strathmore, Taber, Vauxhall and Airdrie.



PITOT TUBE METHOD



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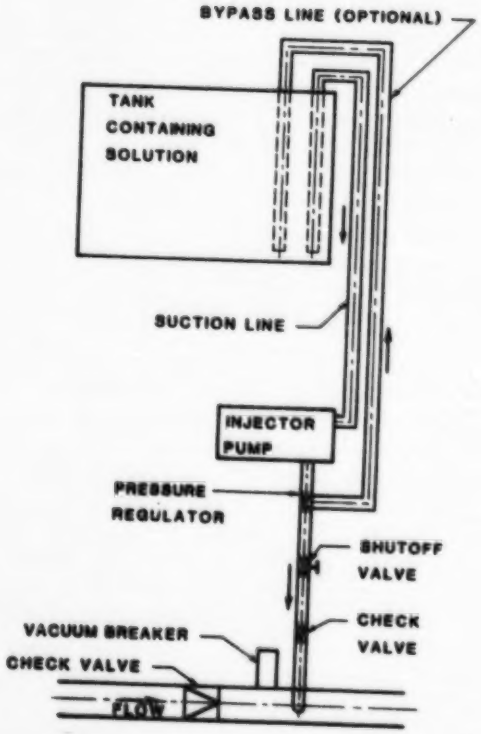
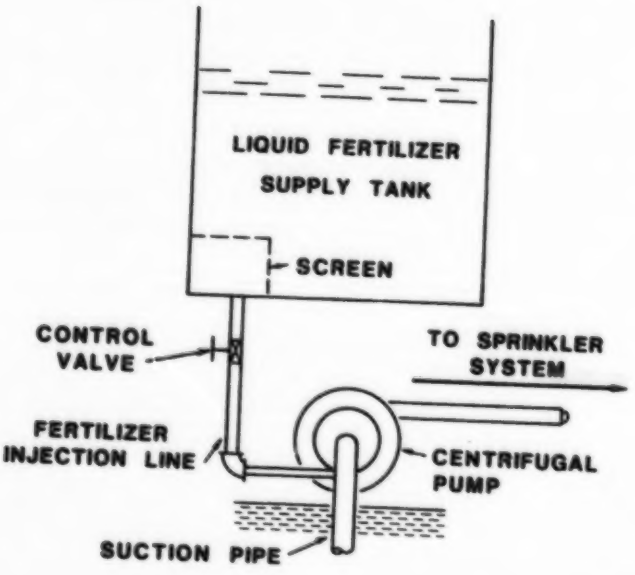


INJECTION PUMP METHOD



PUMP SUCTION METHOD